



ViP2P: XML Warehousing in P2P Networks

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Submitted on 6 Dec 2010

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ViP2P: XML Warehousing in P2P Networks

Ioana Manolescu-Goujot

Equipe Leo

INRIA Saclay-Île-de-France & LRI, Université de Paris Sud-11



Supported by: *ANR-08-DEFIS-004 CODEX, INRIA ADT ViP2P & ViRDF*

Leo and friends in front of our lab



Part I

Introduction

Motivation

Distributed data management: old goal (1970)

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- distributed versions of industrial-strength DBMSs
- map/reduce style systems for massively parallel computations

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Distributed data management: old goal (1970)

- distributed versions of industrial-strength DBMSs
- map/reduce style systems for massively parallel computations

Still missing: the **flexible federation**

- high independence of the sites: when to be in, what to store
- **data distribution transparency**
- ... with the usual performance requirements

Distributed warehouses of Web content

Web content

structured documents, schemas, annotations, concepts, mappings, Web services, inter-document links

Web content warehouse

Distributed database of selected content, whose users may:

- publish resources
- connect (annotate, map, link...) existing resources
- update resources
- **enhance** resources by combining them

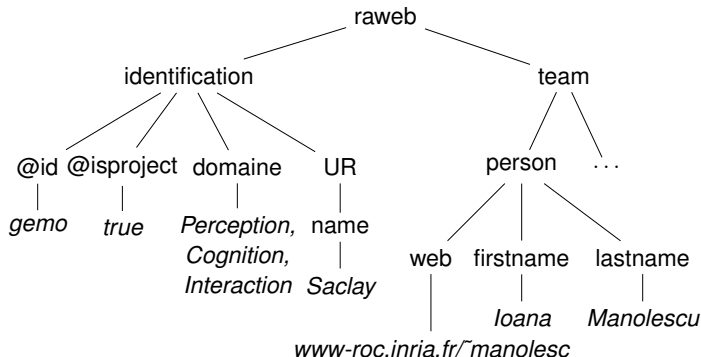
In the style of the RNTL WebContent project (2005-2009)

INRIA annual activity report in XML

<https://irabot.inrialpes.fr/RA2009/gemo.xml>

```
<?xml version="1.0" encoding="iso-8859-1"?>
<!DOCTYPE raweb PUBLIC "raweb2.dtd">
<raweb year="2009">
  <identification id="gemo" isproject="true">
    <shortname>gemo</shortname>
    <domaine>Perception, Cognition, Interaction</domaine>
    <UR name="Saclay"/>
  </identification>
  <team>
    <person>
      <web>http://www-roc.inria.fr/~manolesc</web>
      <firstname>Ioana</firstname>
      <lastname>Manolescu</lastname>
    </person>...
  </team>...
</raweb>
```

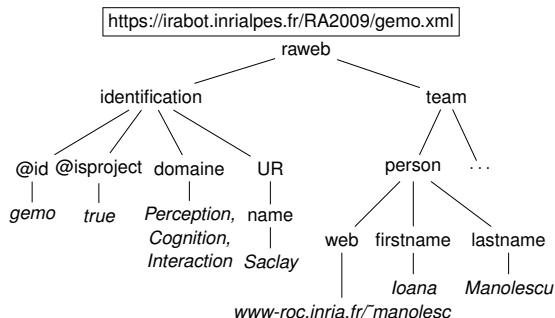
INRIA annual activity report in XML



- (Very) popular data exchange format
- Many W3C standards + efficient tools

XML and the Semantic Web

XML



RDF

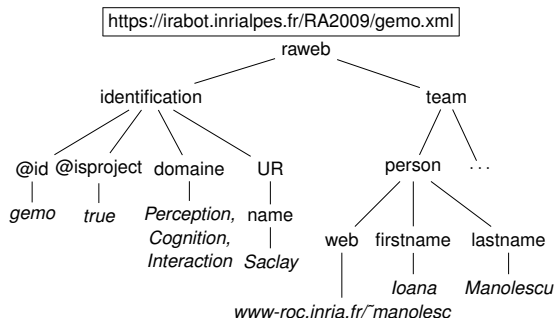
<http://gemo.saclay.inria.fr>
wroteReport
<https://irabot.inrialpes.fr/RA2009/gemo.xml>

<http://gemo.saclay.inria.fr>
coordinates
<http://codex.saclay.inria.fr>

<http://codex.saclay.inria.fr>
hasType
<http://www.inria.fr/types.xsd#ContratFR>

XML and the Semantic Web

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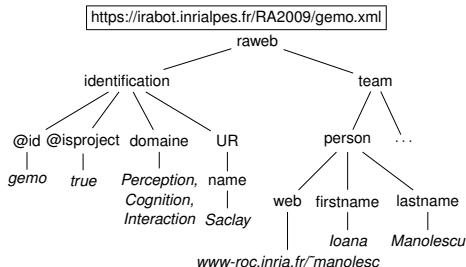
<http://codex.saclay.inria.fr>
hasType
<http://www.inria.fr/types.xsd#ContratFR>

Possible queries

- European projects involving at least two INRIA teams?
- Most frequent keywords for each INRIA theme?
- PhD students co-supervised with a foreign University?

Distributed warehouses of Web content

Distributed XML



<http://gemo.saclay.inria.fr>

<http://codex.saclay.inria.fr>



Distributed RDF

Serv. Inf.
Sci. Tech.
INRIA

<http://pierre.senellart.com>
collaboratesWith
<https://gemo.saclay.inria.fr>

Indiana
Univ.

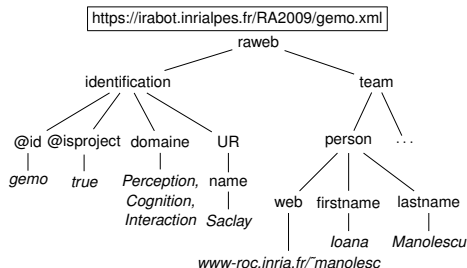
<http://pierre.senellart.com>
coordinates
dbweb.enst.fr/events/sigmod10contest/

Splittd
Desktop

<http://gemo.saclay.inria.fr>
possibleCollaborator
<http://www.splittd-desktop.com/fr/>

Distributed warehouses of Web content

Distributed XML



<http://gemo.saclay.inria.fr>

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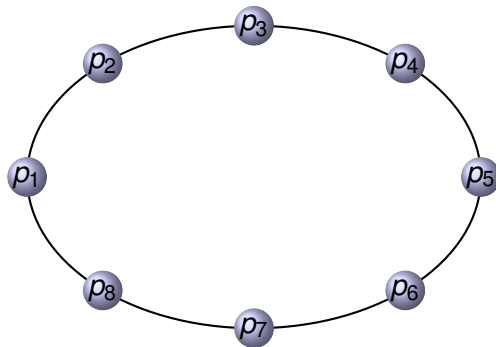
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Splitted
Desktop

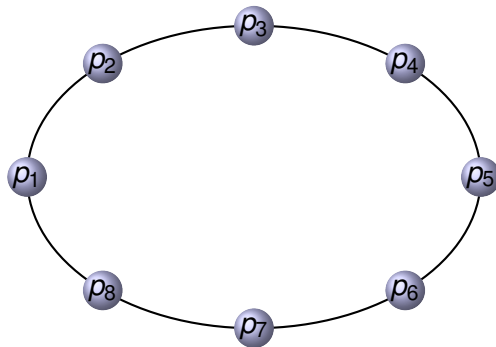
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possibleCollaborator
<http://www.splitted-desktop.com/fr/>

- French researchers involved in ACM conference organization?
- Possible collaborators for a data management project in the clouds?

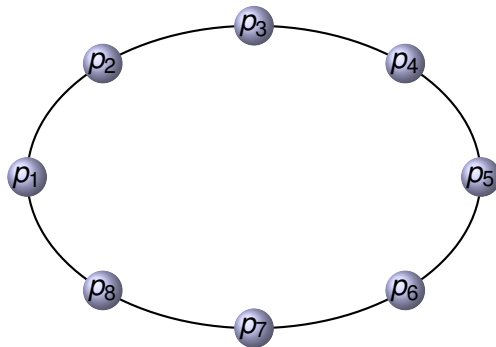
Distributed hash tables



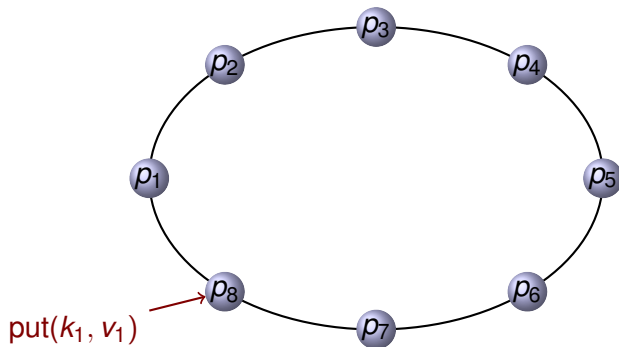
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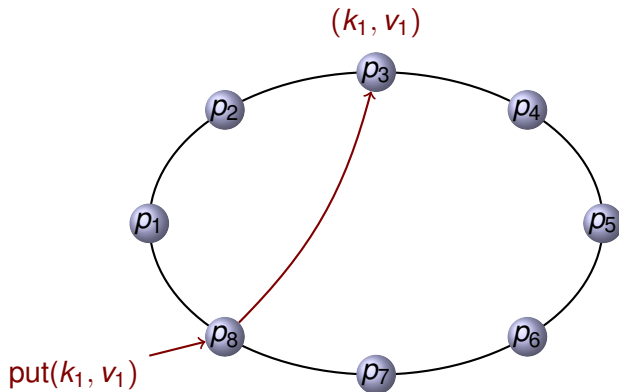
Distributed hash tables



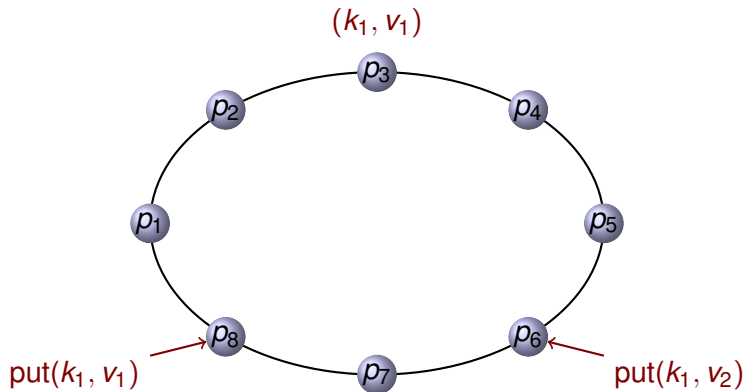
Distributed hash tables



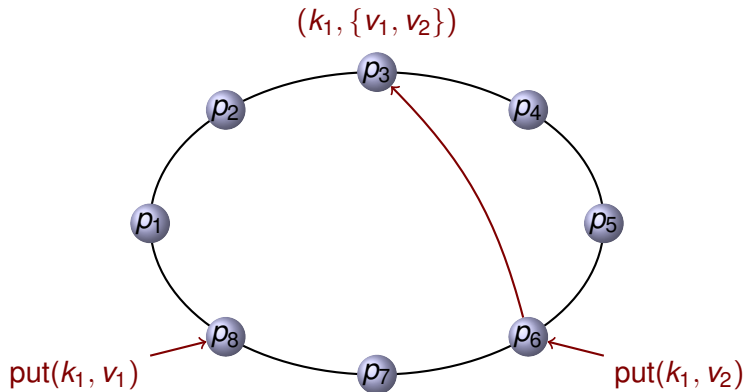
Distributed hash tables



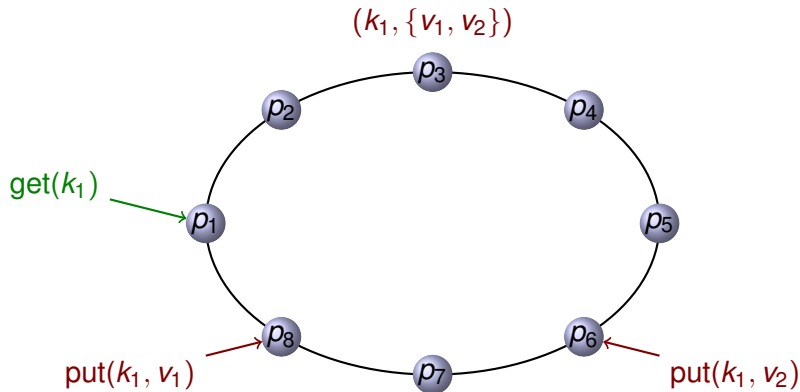
Distributed hash tables



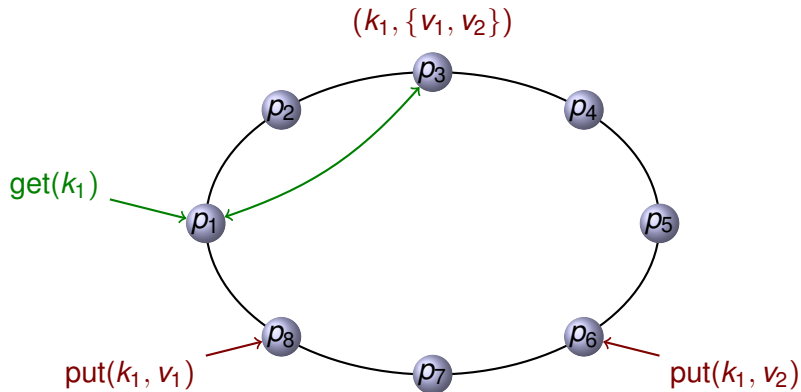
Distributed hash tables



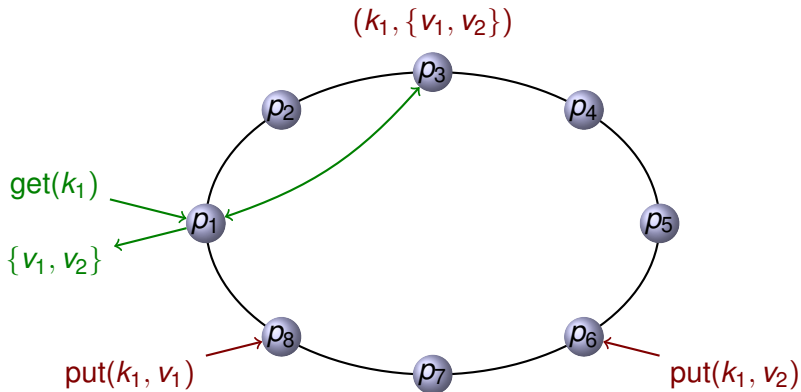
Distributed hash tables



Distributed hash tables



Distributed hash tables



What distributed hash tables provide

Dynamic peer networks

- each peer is assigned an **id** \Rightarrow **address range**
- bound of $\log_2(N)$ hops to route a message to peer
- **network re-adjustment** when peers join or leave: peers' address spaces stretch and contract

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(Key, value) stores = basis for content sharing

- **index** the resources by **keys**
- **look up** resources by **keys**

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Main DHT functionality

Small shared memory \Rightarrow resource catalog

From DHTs to distributed data management

Functionalities to add

- data indexing
- **storage** for application data and even DHT index data
- local query processing
- **distributed query processing**: operators, including **data transfers**, optimization . . .

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Reliability

- | | |
|-----------------|---|
| provided | a peer will eventually answer at each address
some (key, value) replication to handle peer failures
(broadcast to k replicas) |
| to do | resilience of all added functionalities to peer joining/leaving/failing |

Querying distributed data on a DHT

Two types of operations:

- 1 Look up useful data sources in the DHT
 - Documents matching the query
 - Documents which *might* match the query

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- 2 Remaining query evaluation steps
 - **evaluate** sub-queries to extract partial results
 - **combine** partial results
 - **transfer** results to query peer

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Distributed query processing “as usual”

Trade-offs in DHT indexing and query processing

Level of detail of resource indexing

- lookup precision $\nearrow \Rightarrow$ execution time \searrow
- data publication time \nearrow , possibly execution time \nearrow

Data re-placement or clustering

- fewer peers contacted for a query (message no. \searrow , execution time ?)
- data transfers in the absence of queries (message no. \nearrow , total message size \nearrow)

Part II

ViP2P: materialized views on DHTs

5 Credits

6 ViP2P overview

7 ViP2P views

8 ViP2P rewritings

9 The distributed platform

Joint work with

Students

- Konstantinos Karanasos, Asterios Katsifodimos, Spyros Zoupanos (PhD 2009)
- Martin Goodfellow (U. Strathclyde), Silviu Julean (UVT, Romania), Varunesh Mishra (IIT Kanpur), Alexandra Roatis (UVT, Romania)

Engineers

Jesús Camacho-Rodriguez, Julien Leblay, Alin Tilea

Friends from abroad

Angela Bonifati (CNR Italy), Vasilis Vassalos (AUEB, Greece)

Web data sharing in ViP2P

Web data:

- XML documents
- RDF annotations

Web data sharing in ViP2P

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Choices:

Web data sharing in ViP2P

Web data:

- XML documents
- RDF annotations

Choices:

- peers retain control over the data they store/publish
 - no global schema
 - **documents** published independently
 - **annotations** (triples) can freely connect content
- content is re-distributed: peers may accumulate results of long-running queries
- peers share their accumulated results with others

Behind the scene: distributed materialized views

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Long-running query = subscription = view

Declarative specification of results that the peer is interested in

- tree pattern \Rightarrow matches an individual document
- tree patterns with value joins \Rightarrow matches across distinct documents
- corresponding XQuery dialect

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Easier for tree pattern views

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Query planning = rewriting queries using views

Find relevant views \Rightarrow rewrite the query \Rightarrow optimize the rewriting

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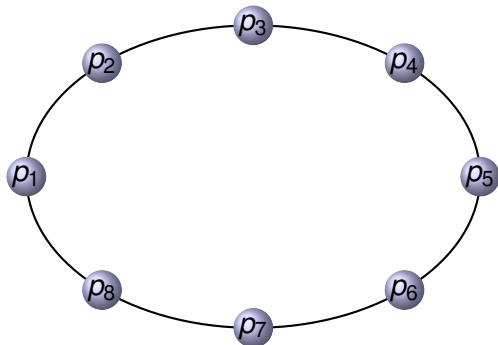
Query planning = rewriting queries using views

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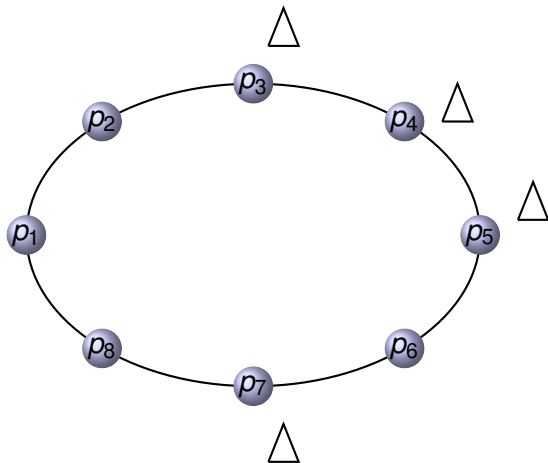
Query execution = distributed query processing

With XML- and RDF-specific bells & whistles

Publishing and querying in ViP2P



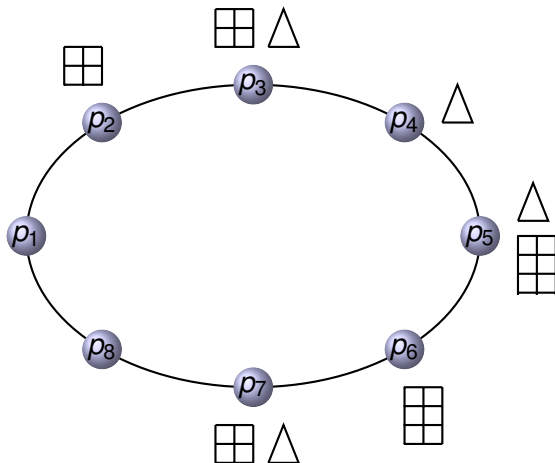
Publishing and querying in ViP2P



The peers may store:

- documents, annotations

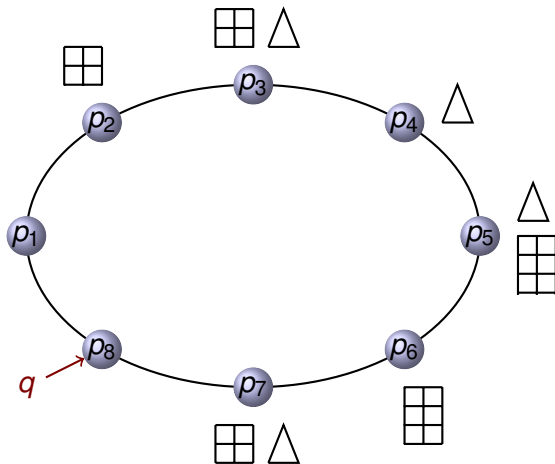
Publishing and querying in ViP2P



The peers may store:

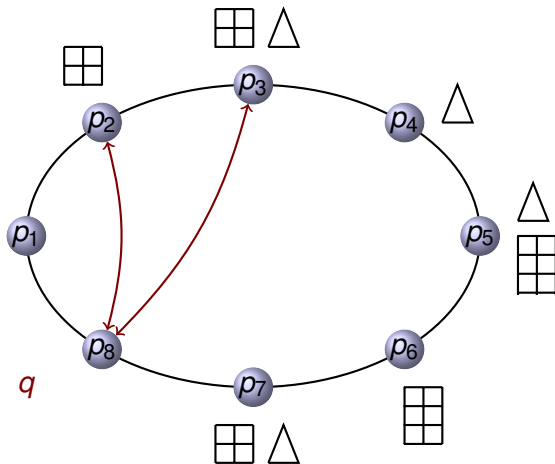
- documents, annotations
- views

Publishing and querying in ViP2P



When q arrives:

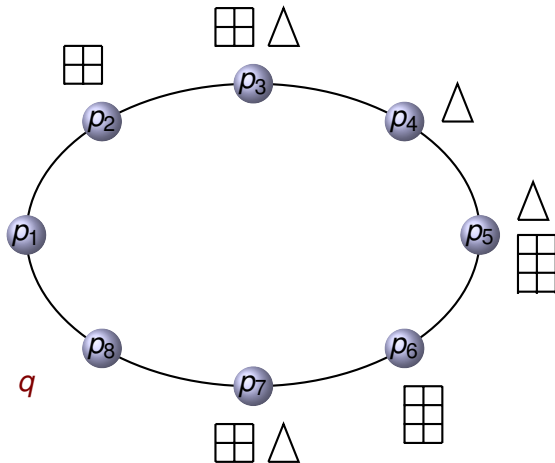
Publishing and querying in ViP2P



When q arrives:

- view definition lookup

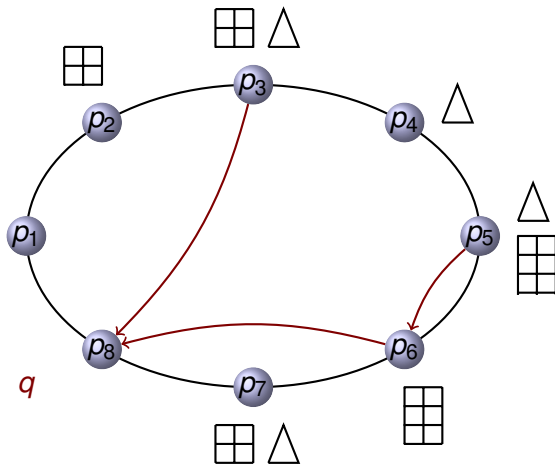
Publishing and querying in ViP2P



When q arrives:

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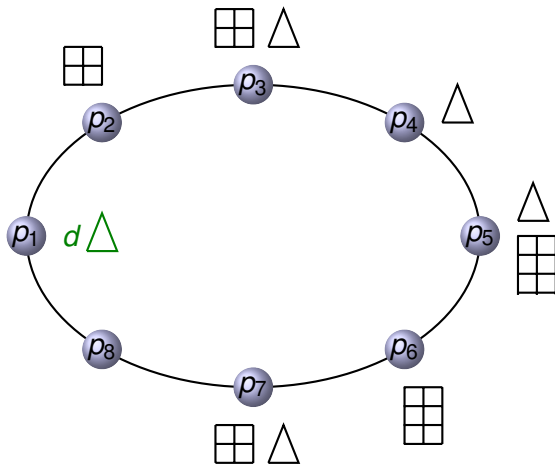
Publishing and querying in ViP2P



When q arrives:

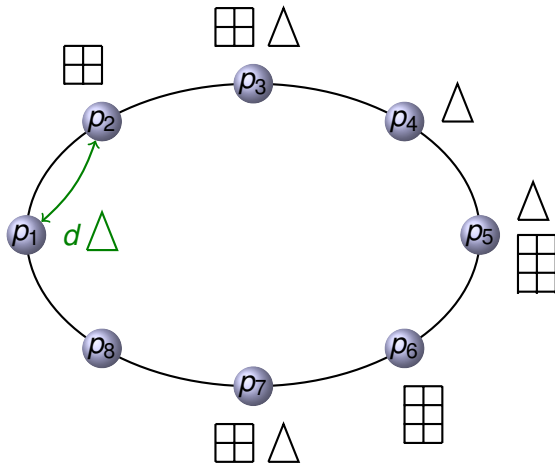
- view definition lookup
- rewriting
- execution of physical plan

Publishing and querying in ViP2P



When d arrives:

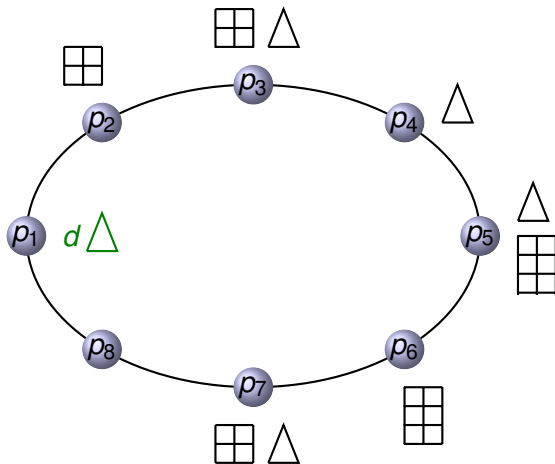
Publishing and querying in ViP2P



When d arrives:

- search view definitions for which $v_i(d) \neq \emptyset$

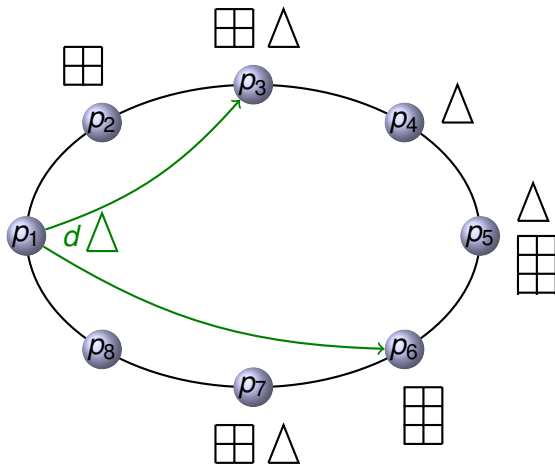
Publishing and querying in ViP2P



When d arrives:

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Publishing and querying in ViP2P

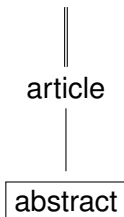


When d arrives:

- search view definitions for which $v_i(d) \neq \emptyset$
- compute $v_i(d)$
- send results

Sample views

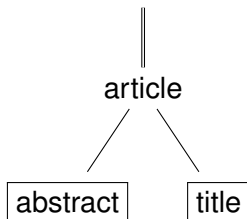
All article abstracts



URI	abstract
http://peer1.com/doc1.xml	Databases...
http://peer2.com/f2.xml	XML processing...
...	...

Sample views

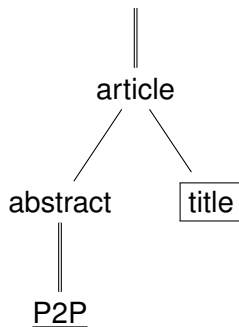
Titles and abstracts of all articles



URI	abstract	title
...

Sample views

Titles of all articles having “P2P” in the abstract



URI	title
...	...

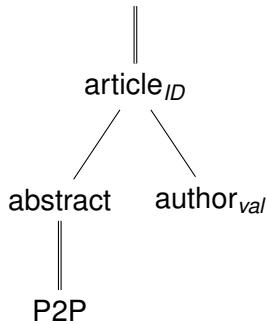
Sample views

URIs of all documents containing
articles having “P2P” in the abstract



Sample views

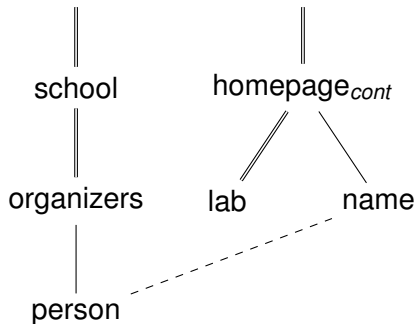
IDs and authors of all articles having
“P2P” in the abstract



URI	article.ID	author.val
...

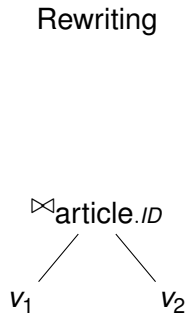
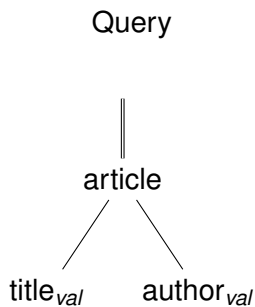
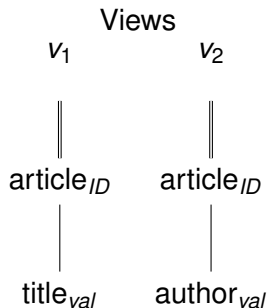
Sample views

Homepages of all WebDam summer school organizers



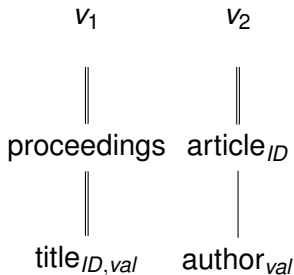
URI1	URI2	homepage.cont
...

Sample rewritings

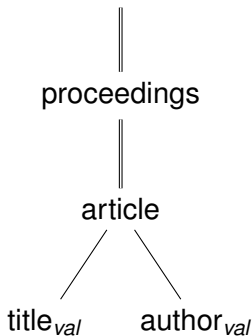


Sample rewritings

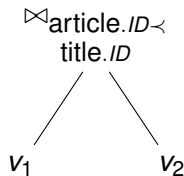
Views



Query

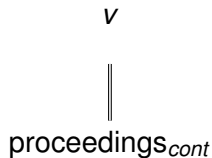


Rewriting

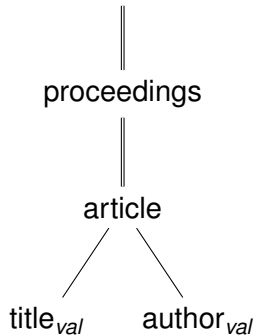


Sample rewritings

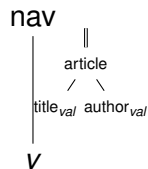
Views



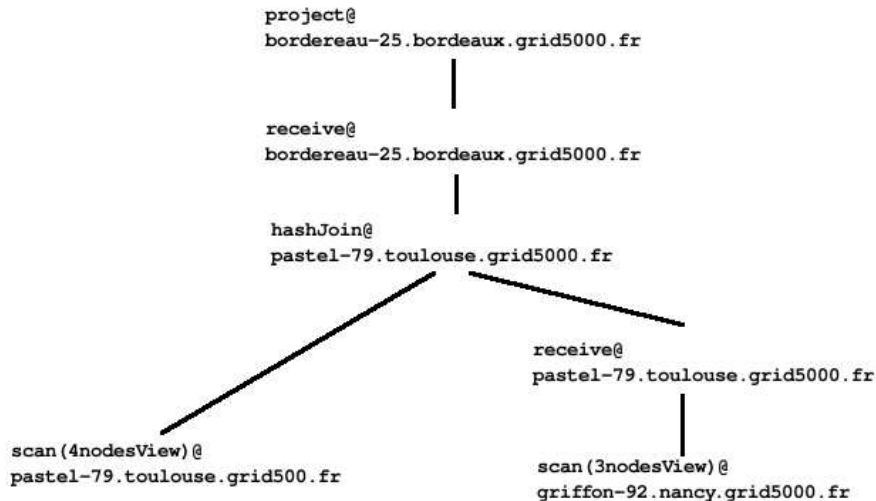
Query



Rewriting



Sample physical rewriting plan



ViP2P platform

- 70.000 Java lines (330 classes) and decreasing :)
- Uses Berkeley DB (version 3.3.75) to store view data
- Uses FreePastry (version 2.1) as our DHT network
- Experiments carried on *Grid5000* using **250 machines**
- Deployed on **1000 ViP2P peers**

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Algorithms inside:

- SAX-based custom processor for computing $v(d)$ + identifiers
- Iterator-based execution engine, (nested) tuples
- Send/receive for distributed execution + URI compression
- Many query optimization strategies

Indexing views for view materialization

View indexing

For each view v and node label l in v , put (l, v)

For each view v and constant k in v , put (k, v)

Indexing views for view materialization

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For each view v and node label l in v , put (l, v)

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View lookup

For each document d and node label l in d , get(l)

Indexing views for view materialization

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if v uses a tag/keyword not present in d
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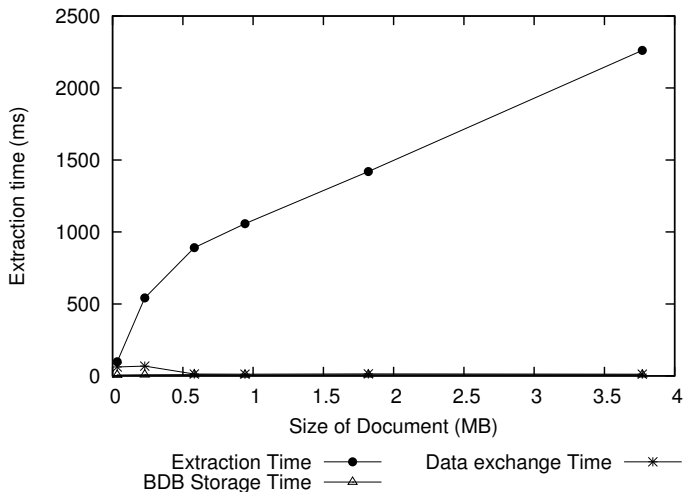
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then discard v

Evaluate the filtered view set on d

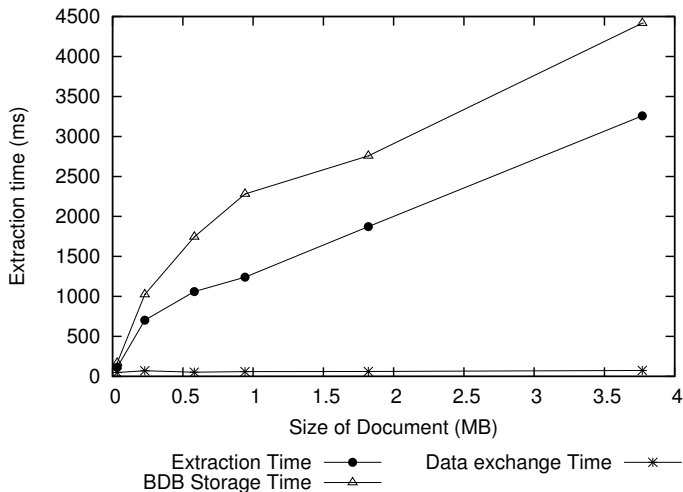
View materialization

View + documents = few results



View materialization

View + documents = many results



Indexing views for query rewriting

View indexing

For each view v and node label l in v , put (l, v)

For each view v and constant k in v , put (k, v)

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View lookup

For each query q and label l in q , get(l)

For each query q and constant k in q , get(k)

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View lookup

For each query q and label l in q , get(l)

For each query q and constant k in q , get(k)

Filter the views thus obtained:

if v cannot be embedded in q
then discard v

Indexing views for query rewriting

View indexing

For each view v and node label l in v , put (l, v)

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For each query q and label l in q , get(l)

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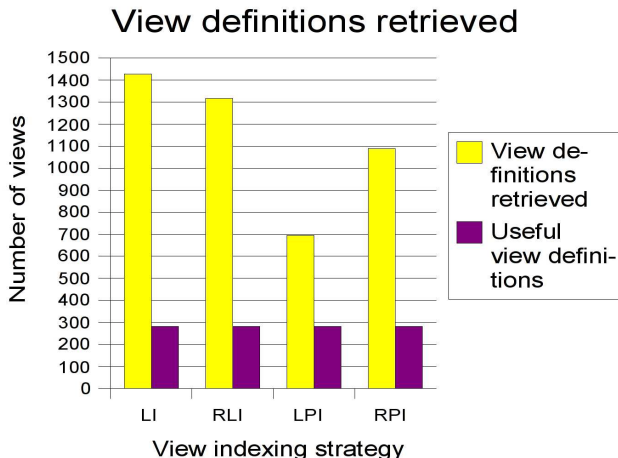
Filter the views thus obtained:

if v cannot be embedded in q
 then discard v

Rewrite q with the filtered view set

View look up performance

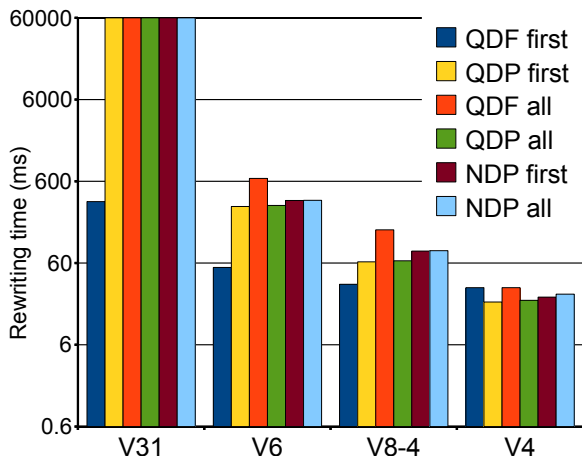
1440 views related to a 32-nodes query q



View rewriting performance

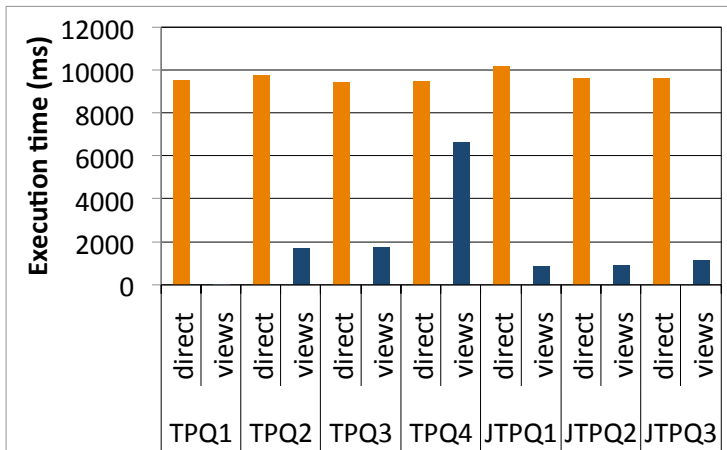
We find **minimal** rewritings

NP-hard problem; heuristics for finding some rewriting fast



The interest of view-based rewriting

Almost-XMark queries



Part III

Summary

We have

A distributed engine for sharing XML data based on materialized views

We have

A distributed engine for sharing XML data based on materialized views

We are working on

- 1 XML+RDF management (K. Karanasos, F. Goasdoué)
- 2 Self-adaptive views (A. Katsifodimos, J. Camacho-Rodriguez, V. Mishra)
- 3 Incremental view maintenance (M. Goodfellow, A. Bonifati)
- 4 Query optimization (A. Roatis)

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A distributed engine for sharing XML data based on materialized views

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Blue sky

- 1 Pure RDF management in P2P
- 2 Moving the back-end into the clouds (EnergieNet)

Closest related works

DHT-based sharing of relations [LHSH04]

DHT-based XML indexing [GWJD03, BC06, SHA05, AMP⁺08]

DHT-based shared XML caches [LP08]

XPath query rewriting [BOB⁺04, XO05, CDO08, TYÖ⁺08]

- XPath: wildcard *, union
- Rewritings: intersection, navigations, joins

Rewriting with structural constraints [ABMP07]

- Centralized setting
- Dataguide [GW97] constraints

Layered architecture for Web content warehousing [AAC⁺08]

RDF querying and reasoning on DHT [KMK08, LIK06]

Thank you!

<http://vip2p.saclay.inria.fr>

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